

1 delivery pressure required for the hydrocarbon feeds,  
2 and to limit the reaction chamber tube wall  
3 temperatures to less than 1600°F, and preferably in the  
4 range of 1300°F to 1500°F, in order to allow extended  
5 life of the tube using relatively inexpensive tube  
6 alloys.

7 In each embodiment, a portion of the  
8 combustion chamber is configured to form an annular  
9 convective chamber to enhance heat transfer from the  
10 combustion products to the tubular reaction chamber.

11 A further object is to provide endothermic  
12 catalytic reaction apparatus, comprising

13 a) a combustion chamber,  
14 b) a tubular reaction chamber having two  
15 generally tubular legs extending in generally parallel,  
16 spaced apart relation within the combustion chamber,

17 c) catalyst within said reaction chamber  
18 for reacting with a hydrocarbon and steam received  
19 within the reactor chamber, to produce hydrogen and  
20 carbon dioxide,

21 d) a radiant burner within the combustion  
22 chamber and extending in generally parallel relation to  
23 at least one of said legs, said burner spaced from said  
24 legs,

1           e)    said two legs having axes, and said  
2 burner having an axis which is spaced in offset  
3 relation to a plane defined by said leg axes.

4           In yet another embodiment, the tubular  
5 reaction chamber comprises a straight tubular outer  
6 conduit concentrically disposed around an inner  
7 conduit. Catalyst is contained in the annular space  
8 between the outer conduit wall and the inner conduit  
9 wall. The tubular reaction chamber is configured so  
10 that the flow of reactant gas is directed  
11 longitudinally through the annular catalyst space in  
12 one direction and returns down the inner conduit space  
13 in the opposite direction. A portion of the tubular  
14 reaction chamber extends into the combustion chamber.  
15 One end of the tubular reaction chamber, containing  
16 both an inlet means that is in communication with the  
17 annular catalyst space and an exit means that is in  
18 communication with the inner conduit space, extends  
19 outside of the combustion chamber. A radiant burner is  
20 oriented to direct a flux of radiant energy to the  
21 surface of the outer conduit of the tubular reaction  
22 chamber. If a multiplicity of such tubular reaction  
23 chambers are used, they can be oriented concentrically  
24 around a centrally disposed radiant burner that  
25 uniformly radiates in a 360 degree arc. The radiant

1 burner may consist of metal fiber material, or ceramic  
2 fiber material.

3           These and other objects and advantages of  
4 the invention, as well as the details of an  
5 illustrative embodiment, will be more fully understood  
6 from the following specification and drawings, in  
7 which:

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9                           **DRAWING DESCRIPTION**

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11           Fig. 1 is an elevation showing assembled  
12 components of the endothermic catalytic reaction  
13 apparatus;

14           Fig. 1a is a section taken on lines 1a-1a of  
15 Fig. 1;

16           Fig. 2 is a diagrammatic view of dimensional  
17 characteristics of the Fig. 1 and 1a assembly;

18           Fig. 3 is a view like Fig. 1, but showing a  
19 modification;

20           Fig. 3a is a section taken on lines 3a-3a of  
21 Fig. 3;

22           Fig. 4 is a view like Fig. 1, but showing an  
23 additional modification; and